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Esthetic Smile Analysis In Mathematical Proportion: A Study

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Abstract
Proportion is the certain ratio between parts, and proportional means a proper correlation of parts among themselves. Mathematical proportions can be used to relate the successive width of maxillary anterior teeth to achieve the aspects of esthetics in dentistry. The golden proportion, the recurring esthetic dental (RED) proportion, and the golden percentage are theories introduced in this field
Aim: To analyze smile in three different mathematical proportions and relate these proportions to the successive width of maxillary anterior teeth.
Material and Methods: A sample of 100 subjects (50 males and 50 females) was evaluated. Each maxillary anterior tooth was digitally measured. Once the measurements were recorded, the theories were applied and the data was analyzed statistically.
Results: The golden proportion was found to exist in 58% of the subjects, between perceived maxillary anterior teeth in natural dentition. The value of RED proportion was not constant, and as one moved distally, this proportion gradually increased. Furthermore, the results revealed that golden percentage was rather constant in terms of relative tooth width. Central incisor represented 22%, lateral incisor 15% and canine 13% of the width of six maxillary anterior teeth, as viewed from the front
Conclusion: The golden proportion can be applied if percentages are adjusted, taking into consideration the ethnicity of the population.

Key Words
Esthetic dentistry, golden proportion, recurring esthetic dental (RED) proportion, golden percentage.

Quick Response Code

Introduction

No human inquiry can be called science unless it pursues its path through mathematical exposition and demonstration. "Leonardo da Vinci".

In the search to create esthetically pleasing restorations, several authors have suggested the use of geometric or mathematic proportions to describe the relationship between maxillary anterior teeth across the midline. There has always been a long argument regarding what constitutes good dental esthetics. When the term esthetic and unesthetic is used, the connotation is that something is seen which is pleasant or unpleasant. This complex process is not merely a rod and cone function. The visual stimuli pass to the centre of vision where the physiological unit can engender a pleasant or unpleasant psychological response. It can also vary from person to person depending on personal experiences and social surroundings[1]

Beauty is not absolute but extremely subjective and perception is determined by the senses, knowledge and preferences of each individual. The lip line, alignment of teeth, symmetry, color of teeth and incisal fit with the lip line, all remain important determinants.[2] For achieving a pleasing dental and facial esthetic, the size and the form of the maxillary anterior teeth have always been considered to play an pivotal role.[3] The mesio-distal width is purposed to be more crucial then inciso-gingival length. and it is a matter of discussion how the width should be predicted.[4]

Different proportions are described in the literature for the size of maxillary anterior teeth. Golden proportion[1], [5] is based on the theory that a relationship exists between the beauty in nature and mathematics. It states that the width of maxillary lateral incisor, when viewed from front, should be in Golden proportion to the width of maxillary central incisor. Thus, the width of maxillary lateral incisor should be 62% the width of maxillary central incisor and the width of maxillary canine should be 62% the width of resulting lateral incisor. Golden Percentage proportion given by Snow states that the width of maxillary central incisor should be 25% the intercanine distance, when measured from distal of canine on one side to the distal of canine on the contralateral side in the frontal view. Width of maxillary lateral incisors and canines should be 15 and 10%, respectively, of the intercanine distance[6] Ward suggested the recurring esthetic dental (RED) proportion as a result of his study in which he described the RED proportion as the proportion of the successive width of the teeth remaining constant when progressing distally from the midline.[7]

The present study evaluates the prevalence of the golden proportion, RED proportion and the golden percentage between the widths of the maxillary anterior teeth in individuals with natural dentition. in a selected sample of north Indian population.

Aims and objectives:
To analyze smile in three different mathematical proportions i.e. golden proportion, RED proportion and the golden percentage. Objectives were to relate these proportion to the successive width of maxillary anterior teeth and evaluate their prevalence in north Indian population.

Materials And Methods

Subject selection
A sample of 100 subjects (50 males and 50 females) from M. M. College of dental sciences Mullana were selected for the study.

Inclusion criteria
Subjects: Indian origin; natural dentition in maxillary anterior region.

Inclusion crtiteria included:
1. Age range of the study sample was 18-27 years
2. Subjects having permanent dentition
3. Bilateral class I canine relation .

The exclusion criterion :
1. Any orthodontic treatment history
2. Unpleasant dental alignment (crowding, spacing, rotation)
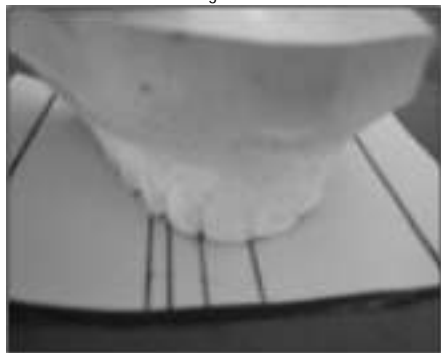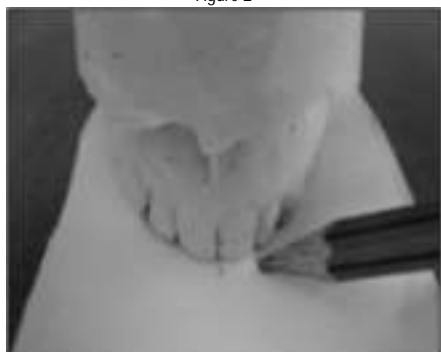3. Any restorations, crowns or fracture in anterior teeth

Figure 1

Figure 2

Figure 3

Measurements
On the basis of exclusion and inclusion criteria 100 subjects were selected.
Alginate impressions (Plastalgin, Septodont, France) of maxillary arch of selected subjects were made. The impressions were poured in the dental stone (Gypstone,Prevest Dent Pro) to obtain the dental casts to make the measurements.
Actual width (mesiodistal width) of front teeth was measured using digital vernier calipers. **Figure 1**
For evaluating golden proportion, customized Levin phi grid was used. Taking the width of central incisor as reference the widths of lateral incisor and canine were predicted. For example, if we know the width of the central incisor ,the predicted width of the lateral incisor can easily be predicted by multiplying the width of central by 0.618 or divide it with 1.618 predicted width of canine = predicted width of lateral incisor x golden proportion.
The dental phi grid was made for each cast from the values obtained from golden proportion formula i.e. predicted width. The casts were placed on a dental grid and were viewed from the front with the cast positioned at the eye level. **Figure 2**
Casts were graded as yes if the teeth were coordinating with the reference lines drawn on the grid or no if they were not.
Apparent width (width of maxillary frontal teeth viewed from the front) was measured. The cast was viewed from the front with the cast positioned at the eye level. The widths of each individual tooth visible from this view were marked with a lead pencil and were then measured using the same vernier caliper. **Figure 3**
The RED proportion was calculated by dividing the apparent width of each lateral incisor by the apparent width of the adjacent central incisor and multiplying by
100. Similarly, the apparent width of each

The mean value and standard deviation for the apparent width for males and females are listed in Table 1.

	gender	N	Mean	Std. Deviation	Std. Error Mean
CI	male	50	8.6088	.40293	.08059
	female	50	8.5064	.46404	.09281
LI	male	50	5.9460	.59851	.11970
	female	50	6.3352	.70814	.14163
CAN	male	50	4.0240	.59958	.11992
	female	50	4.5876	1.05786	.21157

canine was divided by the apparent width of the adjacent lateral incisor. and multiplied by 100. If the resultant values are constant, it means the central incisor, lateral incisor, and canine are in RED proportion. The golden percentage was calculated by dividing the width of each central incisor, lateral incisor, and canine by the total width of all six maxillary anterior teeth, multiplied by 100 in order to obtain the golden percentage for each tooth. If the values from canine to canine were 10%, 15%, 25%, 25%, 15%, and 10%, it means the six maxillary anterior teeth are in golden percentage. The data obtained was statistically analyzed.

Results
After applying the formula of golden proportion to the maxillary frontal teeth viewed from the front showed that 58% subjects coordinated with the dental phi grid reference lines and were marked as yes and 42% did not fit Levin's Phi dental grid and were marked as no.
The mean value and standard deviation for the apparent width for males and females are listed in **Table 1.**
The mean values and standard deviations of actual widths, golden (predicted) widths of the maxillary frontal teeth of males and females separately are presented in **Table 2.**
Correlation coefficients between the apparent widths and predicted widths for the anterior teeth in relation to gender difference are presented in **Table 3.**
There was a statistically significant correlation between the apparent width

The mean values and standard deviations of actual widths, golden (predicted) widths of the maxillary frontal teeth of males and females separately are presented in Table2.

	Actual width (mean ± std)		Golden (predicted) width (mean ± std)		Apparent width (mean ± std)	
	Male	Female	Male	Female	Male	Female
Central incisor	8.542±0.414	8.482±0.421	8.542±0.415	8.482±0421	8.542±0.412	8.482±0421
Lateral incisor	5.959±0.576	6.220±0.657	5.297±0.258	5.255±0.260	5.736±0.472	5.634±.452
Canine	7.931±0.556	7.653±0.801	3.292±0.192	3.354±0.293	4.256±0.573	4.182±0.296

Correlation coefficients between the apparent widths and predicted widths for the anterior teeth in relation to gender difference are presented in Table 3.

gender			N	Correlation	Sig.
male	Pair 1	CI(app) & CI (pred)	25	1.000	.000
	Pair 2	LI(app) & LI(pred)	25	.501	.011
	Pair 3	CAN(app) & CAN(pred)	25	.320	.119
female	Pair 2	LI(app) & LI(pred)	25	.449	.025
	Pair 3	CAN(app) & CAN(pred)	25	.544	.005

and the predicted width of lateral incisor and canine. In case of females the correlation is better than males.

Apparent width of maxillary lateral incisor came out to be 67.4% of maxillary central incisor and apparent width of canine was 74% of apparent width of maxillary lateral incisor.

Discussion:

Aesthetics has great importance in dentistry becoming synonym of natural, healthy and harmonious appearance. Today the role of dentist is not confined to remedy, but also to maintain esthetics. Several decades ago, the appearance of restorations was of secondary importance as long lasting treatment was the preferred mode of cure. Today esthetic acceptability remains a primary concern.[7]

The concept of Golden proportion has fascinated scientists, architects and artists for more than 2,400 years. The concept of the ''golden proportion'' has often been offered as a cornerstone of smile design theory[1]. The Greeks usually attributed discovery of this concept to Pythagoras or his followers who had come to the conclusion that in order to be beautiful, the repeating units should ideally be in proportion to one another. The golden proportion was described by the Pythagoreans in the sixth century BC, and a little later by the Greek geometrician Euclid. However, long before the Greeks, the Egyptians had found and set up the golden number f (1.618), as the width to length ratio in the Egyptian rectangle was 0.6.8It was not until 1900s when an American mathematician named Mark Barr represented the Golden Ratio by using a Greek symbol (phi, after Phidias, a Greek artist who used it extensively in his work) The ideal proportion for esthetic harmony would be in the ratio of 0.618 to 1.0. Lombardi suggested the Golden proportion to be an important tool to help dentists in predicting the width of the anterior teeth while restoring them.[2] Levin pointed out that ''the width of the maxillary lateral incisor is in the golden proportion to the width of the central incisor and also the width of the maxillary canine to the lateral incisor when viewing from the front.'' He a devised a grid (phi dental grid) with the spaces in golden proportion and suggested that this grid be used to evaluate and develop well-proportioned teeth. It has been considered that the Golden proportion creates proper balance which dictates treatment and develops esthetically pleasing smiles[1].

In dentistry, this concept can be applied easily especially for the upper anterior dentition (from canine to canine) keeping the central incisor as a reference.

The results of study reveal that golden proportion was found in 58% of the sample population when maxillary frontal teeth had been viewed from the front. The results of the present study are supported by studies done by Ong[9],Umer[10] and Ali[11] They also asserted the existence of golden proportion. Gillen and colleagues, in a study of 54 subjects, found that the golden proportion was rarely seen.[12] Mahshid and colleagues also found poor co relation between tooth dimensions and the golden proportion.[13] Other studies have also found that the frequency of the golden proportion in agreeable smiles was quite low[14], [15]. However the measurements made by them were on the frontal images of the subjects having esthetic smile. In the present study the dental phi grid is used for each cast as purposed by Levin.[1] So magnification error in photographs and difference in methodology can be the reason of result variation.

Preston's findings regarding the golden proportion in terms of perceived maxillary anterior teeth width ratios and the mean perceived lateral-to-central incisor and canineto-lateral incisor ratios were that lateral incisors were 66% narrower then the central and that the canines were 84% narrower then lateral incisors when viewed from the front.(apparent width).[16] In our study alsoapparent width of maxillary lateral incisor came out to be 67.4% of maxillary central incisor and apparent width of canine was 74% of apparent width of maxillary lateral incisor .Ward's also purposed the idea to use 70% ratio rather than 61.8 %[17]. Rosenstiel and colleagues found that golden proportion was preferred only with regard to tall teeth[18]. Though our study reveals the presence of advocated proportion in 58% of the population the result could have been better if the range of the ratio may be used. Our study also revealed the definitive gender difference in the existence of the divine proportion. We found the prevalence is more in females. The results are similar to the study done by Hasanreisoglu amongst Turkish population and he found that the dimensions of the central incisors and canines varied by gender.[19] Studies done by Condon[20] andJahanbin[21] also had the same findings. Some authors argue that gender has no significant effect when the golden proportion is applied, but ethnic differences should be considered to determine exactly those percentages that are really golden. New studies on a larger sample need to be done to compare gender difference considering widths of central incisors, lateral incisors and canines of the population belonging to the Indian ethnicity. Review of literature reveals that Golden proportion influences the perception of beauty. Not only among the teeth but also the facial landmarks are in golden proportion to themselves and to teeth. There has been relationship between various facial landmarks and maxillary central incisor width.[22], [23], [24]. Thus our study purposes the existence of the golden proportion though the incidence may be different for various ethnic groups.

Conclusion

Because of variety in nature, various factors may exist in different types of population based on their ethnicity and gender A larger study should be administered to establish the variations in tooth size shape, alignment and the incidence of Golden proportion. This will enable the dentists to follow a fundamental guideline in esthetic treatment of the patients and facilitating a better treatment while considering individual cultural characteristics and perceptions of beauty

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